# Maine Agricultural Experiment Station

BULLETIN No. 83. JUNE, 1902.

## THE GRASS THRIPS.

---

This Bulletin contains a study on the anatomy, histology, development and habits of the grass thrips, (Anaphothrips striata, Osborn.)

---

Requests for the Bulletins should be addressed to the
AGRICULTURAL EXPERIMENT STATION,
Orono, Maine.

# MAINE

# AGRICULTURAL EXPERIMENT STATION,

# ORONO, MAINE.

---

## THE STATION COUNCIL.

PRESIDENT GEORGE E. FELLOWS . . . . . *President*
DIRECTOR CHARLES D. WOODS . . . . . *Secretary*
EDWARD B. WINSLOW, Portland . . . . . } *Committee of Board of Trustees*
VORANUS C. COFFIN, Harrington . . . . . }
JOHN A. ROBERTS, Norway . . . . . }
AUGUSTUS W. GILMAN, Foxcroft . . . *Commissioner of Agriculture*
EUGENE HARVEY LIBBY, Auburn . . . . . *State Grange*
CHARLES S. POPE, Manchester . . . . . *State Pomological Society*
JAMES M. BARTLETT . . . . . } *Members of the Station Staff*
LUCIUS H. MERRILL . . . . . }
FREMONT L. RUSSELL . . . . . }
WELTON M. MUNSON . . . . . }
GILBERT M. GOWELL . . . . . }
GILMAN A. DREW . . . . . }

## THE STATION STAFF.

### THE PRESIDENT OF THE UNIVERSITY.

CHARLES D. WOODS . . . . . *Director*
JAMES M. BARTLETT . . . . . *Chemist*
LUCIUS H. MERRILL . . . . . *Chemist*
FREMONT L. RUSSELL . . . . . *Veterinarian*
WELTON M. MUNSON . . . . . *Horticulturist*
GILBERT M. GOWELL . . . . . *Stock Breeding and Poultry*
GILMAN A. DREW . . . . . *Zoologist*
EDWARD R. MANSFIELD . . . . . *Assistant Chemist*
HERMAN H. HANSON . . . . . *Assistant Chemist*
HERBERT W. BRITCHER . . . . . *Assistant Zoologist*
MARSHALL P. CUMMINGS . . . . . *Assistant in Horticulture*

# THE GRASS THRIPS (*Anaphothrips striata,* Osborn.)

LEWIS R. CARY.

Although the grass thrips is of much and growing economic importance, not only in this State, but in nearly all New England, it has received but little attention in this country, either from the structural or economic standpoint. Only one publication bearing upon the economic importance has been found.*

In 1880 Prof. Herbert Osborn published the description of a species of thrips under the name of *Thrips striata,* which he said caused considerable damage to the grass crop in the eastern states.

In Prof. Comstock's Introduction to the Study of Insects, which appeared in 1882, a species of thrips is described under the name of *Limothrips poaphagus.* This was reported as doing great damage to the early maturing grasses, especially June grass, *Poa pratensis.* Specimens of both of these forms sent to the Bureau of Entomology of the Department of Agriculture for identification were referred to the genus *Anaphothrips.* The specific name *striata,* given by Prof. Osborn, was retained on account of priority.

Before the question of the scientific name of the insect had been finally settled, it was the common custom to speak of it as the "grass thrips," and that name is still commonly applied to it except in strictly scientific writings.

## DESCRIPTION.

A large proportion of the mature insects are females. They vary in length from one millimeter to one and one-half millimeters and are of two forms, winged and wingless. Both forms are comparatively long and slender and taper toward each end from the region of the thorax.

---

* Fernald and Hinds. The Grass Thrips. Treatment for Thrips in Greenhouses. Bul. 67, May, 1900. Hatch Exp. Sta., Mass. Agr. College.

The winged forms are larger than the wingless ones, brown in color, and have two pairs of long slender wings, each of which is reduced to a narrow piece, having two or three short veins, and bearing on its edges two rows of fine hairs, fig. 6, hw and fw. The hairs are placed so that the upper row on each wing crosses the lower row at an acute angle and, when the wings are extended, the hairs on the posterior edge of the fore wing overlap those on the anterior edge of the hind wing. This gives practically the same resistance as if the wings were entire. When the wings are folded they lie along the dorsal wall of the abdomen, nearly its entire length, with the anterior above the posterior pair. Their extremities are bent so that the ends of the wings on each side of the body turn away from each other.

In the wingless forms the wings may be entirely wanting, or they may be represented by small protuberances, fig. 5, wp. This form is light pink in color, and is covered with a thin soft integument. The head is small and tapers toward its anterior end. It bears two small compound eyes and three ocelli. The antennæ are placed on the extreme anterior part of the head, very near to the median line. They are about .2 m m. in length, and each is made up of eight joints. The basal joint is short and stout. The next three joints are flask shaped, the anterior enlarged end of each surrounding the neck of the succeeding joint. The fifth joint is smaller than any of the preceding. The sixth, seventh and eighth joints are fused into one long piece, the sixth being much the longest of these three joints. At the anterior end of each joint, around the rim of the cup, there is a row of rather short stiff spines. There are also a variable number of spines scattered over the surfaces of the several joints.

The mouth is situated on the ventral side of the head and, on account of the arrangement of the mouth parts, is placed so far posteriorly that it opens at a point posterior to the junction of the head and prothorax, fig. 14, mp.

The prothorax, figs. 6 and 14, is short, a little wider than the head, and nearly square in outline as viewed from the dorsal side. The ventral is very much shorter than the dorsal surface, as the head extends farther posteriorly on the ventral than on the dorsal surface, (see fig. 14). It bears along its sides a number of spines, and a few very short spines are scattered over the dorsal surface.

The mesothorax, figs. 6 and 14, msth, is, in the adult, about twice as long as either of the other thoracic somites. In the larva and pupa it is not proportionately so long. It is shaped like a barrel, except that it is thinner dorsoventrally at its anterior end. In the winged form it bears the wings, and in the wingless forms it is either smooth or bears the rudimentary wings. In the former its dorsal surface is broken up into a number of plates which allow for the movement of the wings.

The metathorax, figs. 6 and 14, mtth, is narrow in front and broadens out behind to join the abdomen. On its dorsal surface it has the appearance of being an abdominal rather than a thoracic somite.

Each of the three thoracic somites bears a pair of legs that have the usual number of joints. All of the joints, except the coxa and tarsus, are flattened laterally, fig. 16. The tarsus has at its extremity, in place of the usual claws, a bladder shaped organ, fig. 16, at the sides of which there are two small rudimentary organs that many entomologists interpret as being tarsal claws. The bladder is supposed to represent modified pulvilli.

The anterior pair of legs are quite short and stout, and are attached near the anterior part of the somite. The second pair of legs are somewhat longer and are attached to the posterior part of their somite. The third pair of legs are much the longest and slimmest of the three pairs. They are attached to the anterior part of the somite.

The abdomen is made up of eight somites. It tapers gradually from before backward, the last somite being quite slender. The first five somites are nearly alike in shape. The sixth somite is wedge shaped with its broad end placed on the dorsal surface and its edge on the ventral surface, fig. 14.

The ovipositor is attached at the junction of the sixth and seventh abdominal somites and when not in use fits into a small groove on the ventral surfaces of the seventh and eighth somites. It is made up of four valves, fig. 14, ovp, which are united so as to leave a groove on the dorsal surface, down which the eggs pass at the time of oviposition. The three angles of the ovipositor are sharply serrate, so that it will hold, while being worked into the tissues of the plant.

The males of this species, fig. 3, are not very frequently found, and it is thought that the majority of the females lay partheno-

genetic eggs. The males are not as slender as the females, and they differ from them somewhat in the position and shape of parts. The eyes are placed more dorsally. The prothorax is large, and has a pair of large spines at its posterior angle on each side. The mesothorax is short, and as seen from the dorsal surface, is nearly round in outline. The small metathorax has its line of junction with the mesothorax semicircular, and its posterior outline straight. The abdomen is quite narrow in front and grows gradually wider posteriorly as far as the fourth somite. From this point it tapers gradually to the posterior end of the body. The last somite is modified to form the male copulatory apparatus. This somite bears two pairs of large, long spines.

## LIFE HISTORY.

The adult insects pass the winter months in the dead vegetation at the bases of their host plants, very close to or on the ground, where they are protected by the debris. In the spring as soon as the weather has become sufficiently warm to start the grass, they come out from their winter quarters and begin to lay eggs in the tender leaves of the young grass. The eggs are deposited in the tissues of the blades near their upper surfaces. Fernald and Hind * determined by keeping insects in captivity that each female is capable of laying from fifty to sixty eggs. The first eggs laid hatch in from twelve to fifteen days. Later in the season the time required is materially reduced. In the hot dry periods of the summer they may hatch in a week.

When the larvæ are hatched they seek some sheltered place in which to pass the next stages of their development. At this period of their development they are most frequently found in the sheaths of the blades, especially those of the young stalks, near the ground. In the later stages they sometimes congregate in the upper sheaths of the stem, and then they cause the "silver top," which is the most conspicuous evidence of their work.

The larvae, especially in the later stages, are quite active, running about the leaves inside of the sheath or even on the head, among the flowers. The pupal stage is passed in some quiet place, as at the base of the sheath of some lower leaf. In this stage the insect takes no food and moves only very sluggishly.

* The Grass Thrips. Bul. 67, May, 1900. Hatch Exp. Sta., Mass. Agr. College.

In the early spring months a large proportion of the females produced are of the winged form. They fly about and infest new fields, so that in a very short time a large area may become badly infested with the insects. As the season advances the number of the winged forms becomes less, until in the latter part of the season, September or October, there are very few of the winged form, among all those produced.

### LARVA.

The larva, fig. 1, resembles the adult in shape and color but is smaller. Compared with the adult, the head of the larva is small, the antennae short, and there is not as much difference in the size and shape of the thoracic somites. There are very few spines on the body, a tuft on each of the last two abdominal somites being the only conspicuous ones.

### PUPA.

The pupa, fig. 2, (last larval stage) has a very distinctive appearance. It is encased in an external covering, probably the last moulting case, which disguises the form of the insect to a great extent. The head is about the same shape as in the larva. The antennæ are bent back so that they lie upon the dorsal surface of the head and prothorax, and their covering shows neither joints or spines. The prothorax is shaped like that of the adult. The mesothorax is long and bears on its dorsal surface a pair of wing cases, which in the pupæ of the winged forms extend posteriorly nearly the length of the abdomen. In the pupæ of the wingless forms the wing cases are very short.

### MOUTH PARTS.

*Fig. 4.*

The mouth parts of the Thysanoptera differ very much from those of the other orders of insects. They have, in part, the characteristics of the biting insects, and in part, those of the sucking forms. If we accept the old interpretation, and consider the piercing setæ mandibles, the typical mouth parts are all represented and are not much fused.

The labrum is triangular in shape, but quite unsymmetrical. It is longer on the right than on the left side, the greater part of the attachment of the base of the labrum being on the right side of the median line of the head.

The parts which have been described by most American writers as mandibles are slender bristle-like spines, each of which has an enlargement at its upper end. They are situated inside of the mouth, and when in use extend through the oral aperture. Sections of the head clearly show, as has been mentioned by Garman,* that the upper broad end of these parts are joined to the maxillæ by a short round basal piece. There is a distinct joint between these two parts.

The maxillæ are elongated, triangular in shape, and placed so that they form the lateral borders of the mouth. Near their middle point there is a three-jointed palp.

The labrum is made up of two thickened portions which lie at the side of the mouth below the maxillæ, and a third ventral portion connecting the thickened parts. It bears on its lower third a pair of three-jointed palps. The palps bear spines on the distal end of each joint.

On the left side of the head there is a single unpaired organ, shaped somewhat like one of the piercing setæ, only it is stouter and has the upper portion much thicker. There is nothing on the right side of the head to correspond to this organ except, in some cases a small papilla.

Inasmuch as the piercing setæ are composed of two portions united by a joint, they are not homologous with the mandibles of other Hexopoda, which are in all cases composed of a single piece. They should rather be regarded as specialized lobes of the maxillæ.

The unpaired organ has been interpreted by some writers as an epipharynx which has been shifted to one side. Others consider it to be the left mandible, the right mandible being wanting or rudimentary.

Considering the modification of the parts, and the apparent deficiency of the right side of the head, it would seem that the latter is the most reasonable interpretation.

---

* Garman, H.—The assymetry of the Mouth-parts of the Thysanoptera, American Naturalist, Vol. XXX, July, 1896.

DIGESTIVE SYSTEM AND ACCESSORY GLANDS.

*Fig. 7.*

The alimentary canal is small and short. It is only about one and one-half times the length of the body.

The mouth is little more than a narrow tube through which the setæ project. At its upper end it widens out and joins the pharynx, which runs anteriorly for a short distance, then turns sharply back, and joins the œsophagus. The œsophagus is very narrow and has an exceedingly small lumen. It passes backward over the anterior end of the first thoracic ganglion, and runs back to the middle of the mesothorax, where it joins the mid-intestine.

The mid-intestine is the longest part of the canal. It is separated by three constrictions into four divisions. The first and second divisions of the mid-intestines are of about equal length and together they extend from the mesothorax to the fifth abdominal somite, where they join the third division. At this point there is a sharp turn and the third division runs anteriorly as far as the anterior part of the third abdominal somite. Here, again, there is another turn, and the fourth division runs posteriorly as far as the sixth abdominal somite, where it joins the hind-intestine. At this point the malpighian tubules enter the intestine.

The hind-intestine is small and somewhat convoluted. It shows no division into ileum and colon. At the posterior end it is enlarged to form the rectum.

The mouth and pharynx have a chitinous lining which is quite thick. The anterior part of the œsophagus also has a thin, flexible, chitinous lining. The outer walls of the œsophagus are very thin and delicate and have very few muscle fibers.

The walls of the mid-intestine are much thicker, and are composed of several layers. On the inside is the lining membrane, the cuticula. Just outside of this, with their apices projecting into the lumen of the intestine, is a layer of large pyramidal epithelial cells. These cells are imbedded in a basement membrane of connective tissue, outside of which there are two layers of muscle fibers, one circular and the other longitudinal. Outside of these there is a thin membranous covering.

The epithelial cells in the first two divisions of the mid-intestine are especially active as secreting cells. Part of them are filled with granules that are suspended in the protoplasm of the cell, and others are quite free from these granules. In the posterior divisions of the mid-intestine the epithelial cells are not so large or high, but the arrangement of tissues is the same.

In the hind-intestine the cuticula is very thick and the epithelial cells are small and rather flat. The three inner layers of the hind-intestine are thrown up into folds which are not very noticeable in the anterior part, but are larger in the posterior part. In the rectum the folds are very large and form the so-called rectal glands. On the outside, in the depressions between these ridges, there are six bands of longitudinal muscle fibers. The rectum is larger than the rest of the hind-intestine, and has thick muscular walls. The rectal glands probably have no function as glands but are thought to be of use in closing the intestine.

### SALIVARY GLANDS.

The salivary glands, fig. 7, sg, are two in number. They are situated in the dorsal region of the anterior part of the mesothorax, just in front of the anterior end of the mid-intestine, and dorsal to the œsophagus. The glands are ovate in shape and at their anterior ends give rise to a pair of small ducts which soon unite to form a single median duct. This runs forward, just dorsal to the œsophagus, and opens into the mouth near the oral aperture. The glands are made up of a small number of large cells, which are imbedded in a basement membrane of connective tissue. The cells have large prominent nuclei, and may be seen in different stages of secretion. Some are filled with granules and others have the cell contents free from granules. The lumen of the gland is small and irregular.

The fluid secreted by these glands would seem, from the position of the opening of the duct, to have little digestive function, but rather to serve as a lubricant for the mouth parts.

### EXCRETORY SYSTEM.

The excretory apparatus consists of four large malpighian tubules, fig. 7, mt, which open into the intestine at the junction of the mid- and hind-intestine and extend as far anteriorly as

the first abdominal somite. They lie in the abdomen without any definite arrangement, occupying the spaces between the other organs and are richly supplied with tracheæ.

Each tubule is composed of large cells with prominent nuclei, that are so placed that they give it a spiral appearance. A transverse section shows from five to seven cells around the lumen of the tubule.

### MUSCULAR SYSTEM.

*Fig. 8.*

The muscular system corresponds in its general arrangement to the segmented structure of the body; that is, most of the muscles are arranged inter-segmentally. The typical arrangement is shown in any of the anterior abdominal somites. When a transverse section is taken across one of these somites, fig. 13, four longitudinal rows, each composed of five muscles, are seen. The four rows are placed so that there are two on the dorsal and two on the ventral side.

The ends of these muscles are attached by a sort of tendon to the infolding of the integument between each two somites. In the last abdominal somite the posterior ends of the longitudinal muscles are attached to ridges in the integument. These muscles are bellied so that they are thicker in the middle than at the ends, and each is nearly square in cross section. The longitudinal muscles of the abdomen are all arranged on this plan. By this arrangement one end of the muscles of two somites being attached at practically the same point, it is possible to bring the fulcrum for any movement of the abdomen to the joint between any two somites, the combined action of the muscles of the somites anterior to this point keeping the anterior part of the abdomen rigid. The abdomen may be bent in practically any direction by means of the longitudinal bands of muscles, which may be contracted individually or in combinations, throughout the length of the abdomen, or in any part of it.

Near the middle of each abdominal somite there is, on either side, a pair of muscles which run from the dorsal to the ventral surface, fig. 8, stm. These provide for a dorso-ventral contraction of the abdomen, which is of service in respiration.

In the sixth and seventh abdominal somites there is, in addition to the typical muscles already mentioned, a set of muscles

which have to do with the movements of the ovipositor. These muscles are eight in number, four on either side of the median line. They are attached at their ventral ends to the ovipositor, and run dorsally and somewhat laterally around the intestine to be attached to the dorsal wall of the abdomen. When these muscles are contracted they bring the ovipositor out from its position in the groove on the seventh and eighth abdominal somites, where it lies when not in use, to the position in which it is used in depositing eggs. In this position it is placed at an angle of about thity degrees with the abdomen.

In the thorax the segmental arrangement of the muscles is greatly modified. On the dorsal side there are two rows of longitudinal muscles like those of the abdomen. On the median dorsal line of the mesothorax four muscles are attached. One pair of these muscles runs anteriorly and laterally and is attached to the ventral wall of the prothorax just posterior to the anterior legs. The other pair passes posteriorly and laterally and is attached just posterior to the hind legs. The arrangement of these muscles is such that when they are viewed from the dorsal side they form a cross the four extremities of which are attached to the ventral surface.

Attached to the fold of the integument that lies between the abdomen and metathorax, with their posterior ends overlapping the ventral ends of the posterior pair just mentioned, is another pair of muscles. These converge as they run forward, and are attached to a prominence on the floor of the metathorax near its anterior end. Between the posterior ends of these two sets of muscles another pair of muscles is attached. These diverge as they run forward, and are attached at the bases of the third pair of legs. From this point they converge and at the anterior end of the somite they are attached to the fold of integument between the meta- and mesothorax. Another pair of muscles is attached to the floor of the metathorax; they diverge as they run forward and are attached at the bases of the legs in the mesothorax. From this point they converge and are attached together on the floor of the posterior part of the prothorax.

In the prothorax there is a pair of muscles that has the same arrangement as the muscles last described, being attached at their posterior ends to the fold of integument between the pro- and mesothorax and running forward to the head. These also are attached near the bases of the legs in their somite. Another

pair, attached by a single head in the posterior part of this somite, diverge as they run forward, and are attached to the integumental fold between the head and prothorax. In the anterior part of this somite there are, on each side, three muscles which are attached at their ventral ends to the thorax, and at their dorsal ends to the head. In the posterior part of the head there are six muscles that are attached at their dorsal ends to the thorax and at their ventral ends to the head. These two sets of muscles cross one another at their middle points. The muscles that have to do with the movements of the mouth parts are situated in the anterior part of the head, on its ventral wall. A part of these muscles run anteriorly and dorsally to be attached to the front part of the head. The remainder run dorsally to be attached to the dorsal wall of the head.

Each leg is supplied with four muscles. One of these muscles lies along the floor of the thorax, and is attached at one end to a median ridge of the integument, and at the other end to the fold between the coxa and trochanter. This muscle serves as the flexor of the coxa. The other thoracic muscles of each leg are really the three heads of one muscle, the extensor of the coxa. These muscles are attached to the integument on the dorsal walls of the thoracic somites and at the other end to the integumental fold between the coxa and trochanter. The muscles in the next two joints of the leg (trochanter and femur) are arranged in much the same way, one of them acting as a flexor and the others as extensor. They are attached intersegmentally. In the next joint (tibia) there are only two muscles, one flexor and one extensor. Both of these muscles are continued into the tarsus by tendons. The tarsus has no muscles of its own.

In the winged forms there are, in the thorax, the muscles for the movement of the wings. These consist of two series on each side, one of which elevates and the other depresses the wings. Each series is made up of several muscles. There are two elevators and four depressors. Of these there is in each series, a single muscle that is much larger than the others and that does the greater part of the work in flight. The others serve to keep the wings in their proper position. All of these muscles are attached at one end to the ventral wall of the thorax, and at the other to the wings. The elevators are attached inside, and the depressors outside of the point which serves as the fulcrum for the movements of the wings.

NERVOUS SYSTEM.

*Figs. 7 and 9.*

The central nervous system is concentrated. It consists of five ganglia (morphologically pairs of ganglia), and a single large median nerve cord which passes from the posterior end of the fifth ganglion to the posterior part of the abdomen.

The cerebral ganglion, fig. 7, cg, is large and flat. It is divided superficially into halves by a cleft which is deep in front but shallow on the dorsal and ventral surfaces. Each half of the ganglion is pointed at its anterior end. The optic tracts pass out from the ganglion just posterior to these prominences. There is a slight constriction where they join the ganglion. Just posterior to the optic tract, there is on either side, a prominent swelling, the antennal lobe, from the ventral sides of which the antennal nerves pass anteriorly to the base of the antennae. The posterior part of the ganglion is narrower and thinner than the anterior part and is continued posteriorly over the anterior end of the first ventral ganglion and the œsophagus.

The surface of the first ventral ganglion clearly indicates that it is formed by the fusion of two ganglia, the infraœsophageal and the first thoracic. A well marked constriction separates the two. The nerves which supply the mouth parts are all given off from the anterior part of the ganglion. The nerves to the first pair of legs, as well as those of the muscles and other organs of the prothorax are given off from the posterior part of the ganglion. The nerves which go to the legs are very large, and pass from the side of the ganglion, obliquely to the bases of the legs.

The second thoracic ganglion is connected with the first by a broad commissure. It is much smaller than the first, nearly circular in outline and lies in the anterior part of the mesothorax. The nerves which go to the middle legs are given off from its posterior part. These nerves come from the under side of the ganglion and run obliquely backward to the bases of the legs.

The third thoracic ganglion is small, nearly round in outline, and is connected with the second by a very short broad commissure. It lies in the extreme posterior part of the mesothorax, and sends a large nerve obliquely backward to each of the legs that are attached to the metathorax.

The fourth ganglion is the largest of any in the ventral chain, and compared with them it is long and narrow. It lies partly in the metathorax and partly in the abdomen, and is connected with the third thoracic ganglion by a long slender commissure. It gives off nerves to the organs of the somites which it occupies, and is connected with the somites lying posterior to it, by the long nerve cord passing from its posterior end.

The cord which passes from the fourth ventral ganglion, runs posteriorly to the sixth abdominal somite, where it breaks up into a number of nerve fibers. These supply the reproductive organs, the special muscles of the reproductive organs, and the other organs and muscles in the last two somites of the abdomen.

All of the ganglia correspond very closely in their minute structure. Each ganglion is enclosed in two delicate membranes. Beneath these membranes there is a layer, of varying thickness, made up of large nerve cells, which stain deeply. This layer of nerve cells is thickest at a point a little way from either end. Between these thickened portions the layer of nerve cells is much thinner, and it is entirely wanting where the ganglion narrows down to form the commissure. The nerve cells are pear shaped and a single nerve fiber passes from the smaller end of each cell.

The central part of the ganglion is made up of fibers that run, for the most part longitudinally, except where some large nerve is given off. The commissures are composed entirely of nerve fibers, together with the two envelopes that surround them. The cord which passes from the fourth ventral ganglion is composed entirely of nerve fibers.

### EYES.

The compound eyes, fig. 14, ei. are comparatively small, (about .06 mm. in diameter), placed on the sides of the head just back of the antennæ, and nearly circular in outline. Each eye is made up of from one hundred to one hundred and twenty facets. The facets in the two eyes of an individual may differ in number from ten to fifteen. Each facet is irregular in outline, but approximately circular and is strongly convex on the surface, so that the exterior of the eye has a roughened appearance. The facets near the center of the eye are larger than those near the outside. Those at the center are seven microns in

diameter, while those at the outside range from five to six microns in diameter.

The eyes are deeply colored with a dark brown pigment, which makes them very conspicuous. The ocelli, three in number, are placed between the compound eyes on the dorsal surface of the head, and are arranged in the form of a triangle. The anterior median ocellus is about seven microns in diameter and each posterior ocellus is about ten microns in diameter. They are not very conspicuous, as they have little pigment and are not raised much above the surrounding parts.

### REPRODUCTIVE SYSTEM.

*Fig. 7.*

The reproductive apparatus of the female insect consists of two ovaries, each of which is made up of five ovarian tubes. Each ovarian tube is divided into three sections. First; the terminal thread, at the anterior end, by which that end of the ovary is attached to the dorsal wall of the abdomen. These threads all run together to form a single thread on each side. Second; the terminal chamber, which contains undifferentiated cell elements which give rise to the eggs. Third; the actual ovarian tubes, the chambered part of which contains the eggs.

The ovarian tubes are long and slender and extend from the fifth to the first abdominal somite. They contain no chambers of nutritive matter. At the posterior end of the ovaries there is, on each side, a very short oviduct, which soon unites with its fellow to form the common oviduct, fig. 7, ovd. This extends from the fifth to the junction between the sixth and seventh abdominal somites, where it opens to the exterior at the base of the ovipositor. There is no well marked receptaculum seminalis or accessory sac. The walls of the ovaries are thin, and are made up mostly of connective tissue. The walls of the oviduct are much thicker and well supplied with muscle fibers.

The largest eggs in the lower chambers are about .15 mm. in length and .06 mm. in thickness. They are deeply concave on the surface that is turned toward the median line of the body, and are covered with a strong membrane.

### CIRCULATORY SYSTEM.

The circulatory system consists of a contractile dorsal vessel, the heart, which begins in the sixth abdominal somite and passes forward into the thorax. Here it gives rise to the aorta, which runs forward, ventral to the salivary glands to the head. The heart is very small and lies just below the dorsal wall above the intestine. In almost all of the specimens examined it was so badly collapsed that it was scarcely visible. Its walls are exceedingly thin and have very few muscle fibers. The alary muscles are very poorly developed. Four pairs of ostia were found; these were in the third, fourth, fifth and sixth abdominal somites.

### RESPIRATORY SYSTEM.

*Figs. 14 and 15.*

There are three pairs of stigmata, one at the anterior end of the mesothorax, and one each on the first and seventh abdominal somites. The stigmata are quite large, and have a sieve-like covering to prevent the ingress of solid particles. From the stigmata on the mesothorax tracheæ are supplied to the head and its appendages, to the prothorax and fore limbs, and to the organs and appendages of the meso- and metathorax. The two stigmata on each side of the abdomen are connected by a large tracheal trunk, which runs along the abdomen near its lateral wall. From these trunks three branches are given off in each of the six anterior abdominal somites. One of these branches supplies the dorsal part of the somite, another the ventral part of the somite, and a third passes nearly straight into the body, going chiefly to the viscera. The two posterior somites of the abdomen are supplied by long tracheal branches which come from the stigmata on the seventh abdominal somite. The tracheæ are very small and thin walled, and the walls have a chitinous lining that shows spiral markings. They are supplied to the viscera very abundantly, and serve the double purpose of respiration and to keep the viscera in place.

### FAT BODY.

The fat body is large in all stages of development. In the larva it fills all of the space between the viscera. It is made up of a frame-work of large cells, each of which contains a large drop-

let of fatty matter. In the older stages the most of the fatty matter has been absorbed, but the cells still persist.

### HABITS.

The insects usually live in some part of the grass plant where they are protected from any disturbance. When a sheath is torn down so as to disturb them, they begin to run about seeking some place in which to hide themselves. If they are unsuccessful in their search, they remain practically still and bend up the abdomen as if ready to sting the intruder.

In the act of egg laying the female arches the body so as to bring her weight to bear upon the ovipositor, which is slowly worked down through the surface of the leaf into the under lying tissue. The egg is then passed down the groove on the surface of the ovipositor and lodged just beneath the epidermis of the leaf. This process takes about one and a half minutes for its completion. After an egg has been deposited, the insect moves off and begins to feed. It frequently happens that the serrated edges of the ovipositor become so firmly fastened in the tissues of the plant that the insect is unable to free itself and finally dies.

The insects attack a number of the common grasses during the season, but in the early months its ravages are mostly confined to the June grass, *Poa pratensis,* on which the results of its work are the most manifest. As the season advances it is found quite abundantly in timothy, *Phleum pratense,* and on several species of Panicum, Agrostis, and Festuca.

For treatment see page 128.

## REFERENCE LETTERS.

ab abdomen.
abg abdominal ganglion.
ant antennæ.
antn antennal nerve.
cg cerebral ganglion.
cox coxa.
ei eye.
fbc cells of the fat body.
fem femur.
fl fore leg.
fw fore wing.
hd head.
hi hind-intestine.
hl hind leg.
ht heart.
hw hind wing.
hyp hypodermis.
ism intersegmental muscles.
lbm labium.
lhr labrum.
lm muscles of the legs.
ln nerves of the legs.
lp labial palp.
mi mid-intestine.
ml middle leg.
mp mouth parts.
mpm muscles of the mouth parts.
msth mesothorax.
mt malpighian tubules.
mtth metathorax.
mx maxilla.
mxp maxillary palp.
nc nerve cord.
oes œsophagus.
ov ovary.
ovd oviduct.
ovp ovipositor.
ovpm muscles of the ovipositor.
ovt ovarian tubes.
prth prothorax.
ps piercing setæ.
rg rectal glands.
sd salivary duct.
sg salivary gland.
st stigma.
stm sterno-tergal muscles.
tars tarsus.
thor 1 first thoracic ganglion.
thor 2 second thoracic ganglion.
thor 3 third thoracic ganglion.
tib tibia.
tr tracheæ.
troch trochanter.
trt tracheal trunk.
wc wing case.
wp rundimentary wing.

## PLATE I.

Fig. 1. Larva.

Fig. 2. Pupa.

Fig. 3. Adult male.

Fig. 4. Anterior surface of head reconstructed to show the mouth parts in position.

See page 113 for reference letters.

PLATE I.

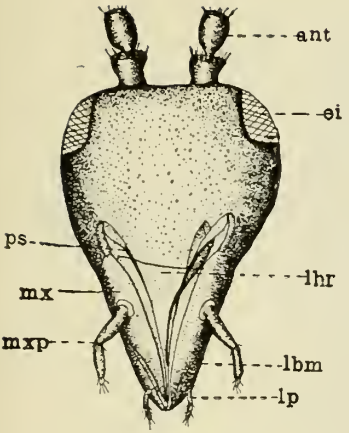


Fig. 4.

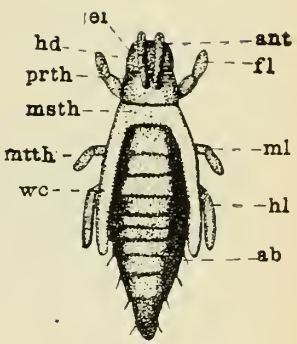


Fig. 2.

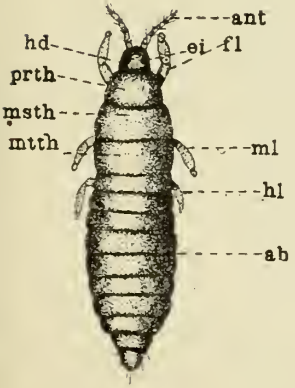


Fig. 1.

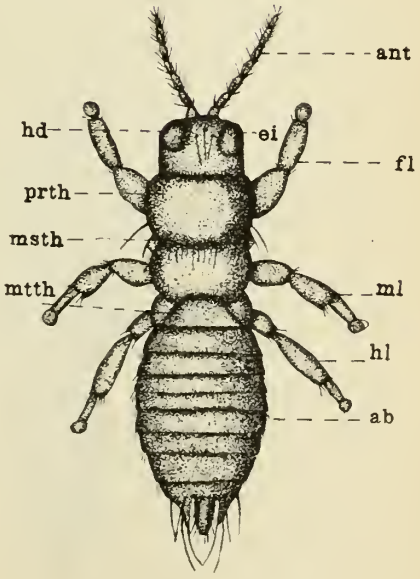


Fig. 3.

PLATE II.

Fig. 5. Adult wingless female.

Fig. 6. Adult winged female.

See page 113 for reference letters.

PLATE II.

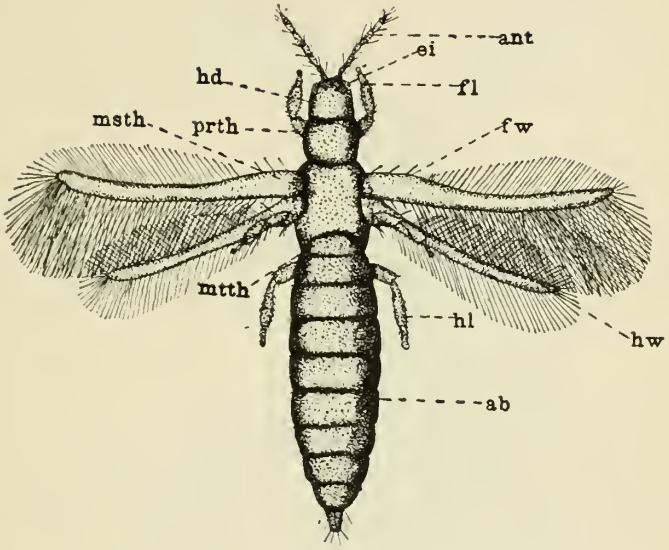


Fig. 6.

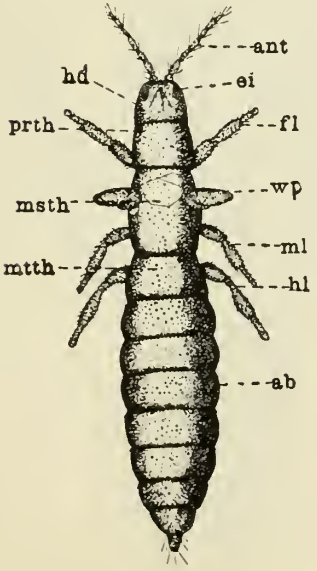


Fig. 5.

## PLATE III.

Fig. 7. Adult wingless female with the dorsal part of the body removed.

See page 113 for reference letters.

PLATE III.

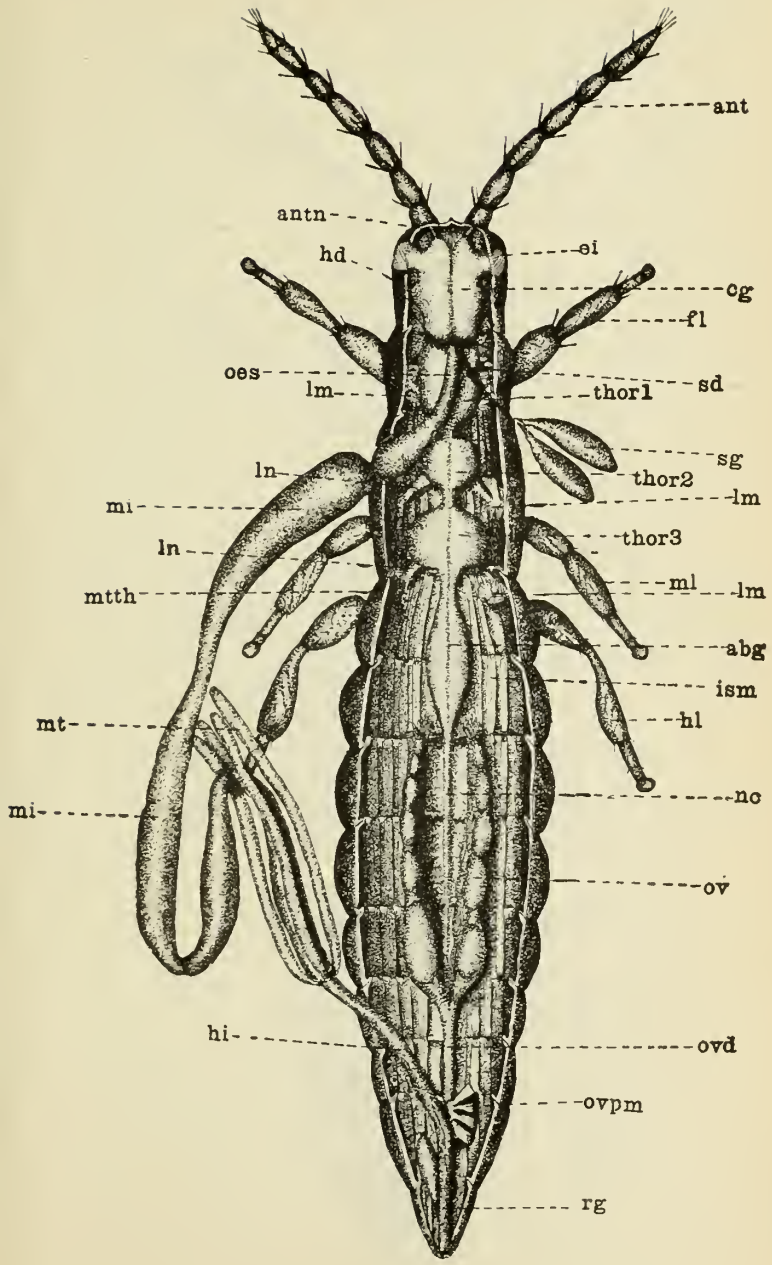


Fig. 7.

PLATE IV.

Fig. 8. Ventral wall of an adult insect showing the arrangement of ventral muscles.

See page 113 for reference letters.

PLATE IV.

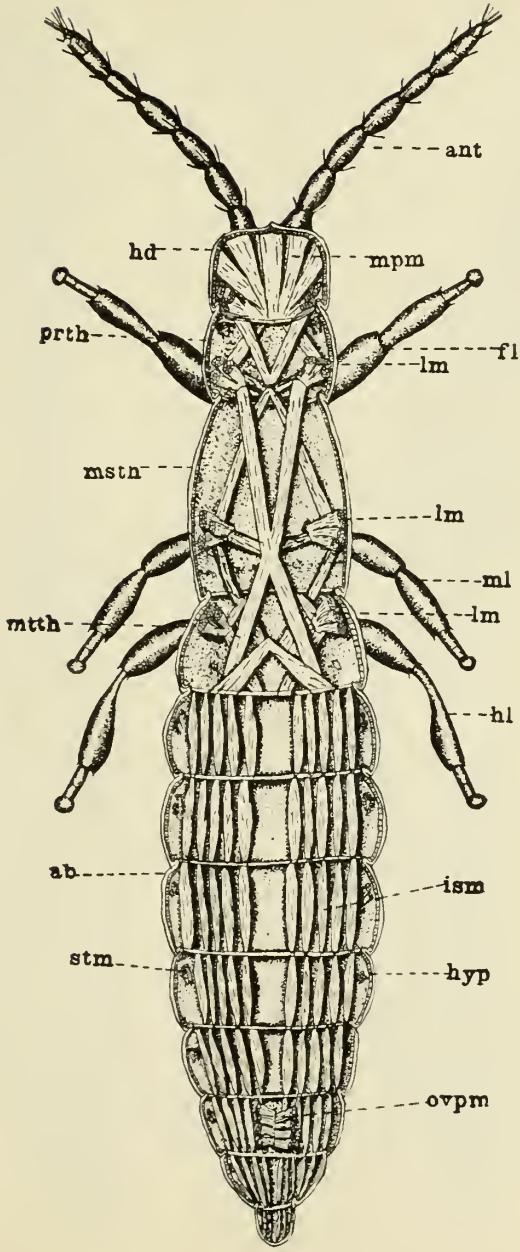


Fig. 8.

## PLATE V.

Fig. 9. Sagittal section through the median plane of the body showing the arrangement of the ganglia.

Fig. 10. Sagittal section through a pupa a little to one side of the median line showing the attachment of the intersegmental muscles.

See page 113 for reference letters.

PLATE V.

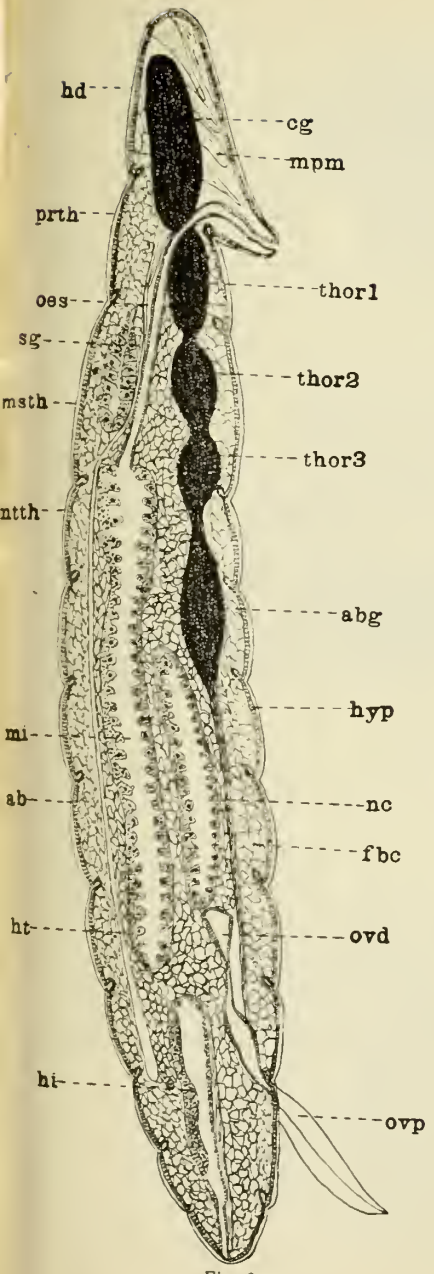


Fig. 9.

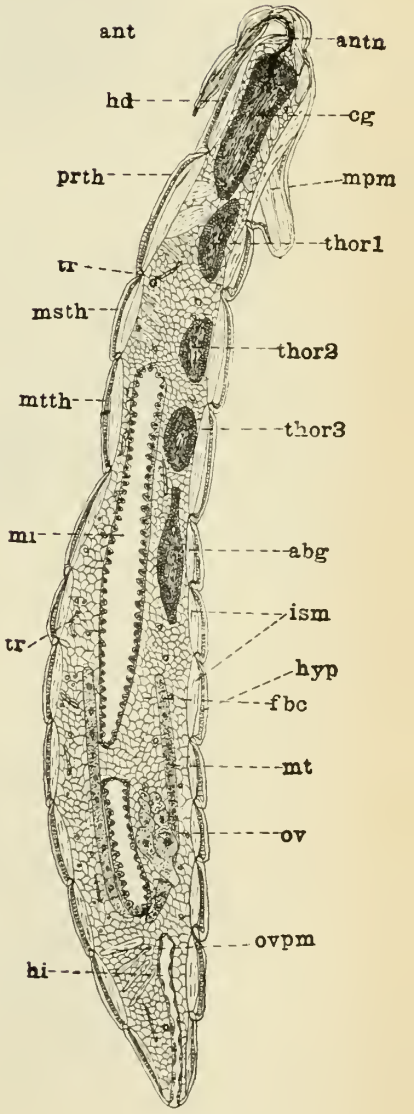


Fig. 10.

## PLATE VI.

Fig. 11. Transverse section through the posterior part of the head of a wingless adult female.

Fig. 12. Transverse section through the posterior part of the first thoracic ganglion.

Fig. 13. Transverse section through the fourth abdominal somite of a winged adult female.

See page 113 for reference letters.

PLATE VI.

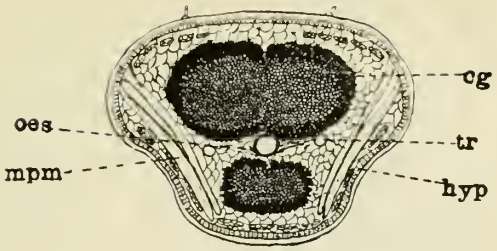


Fig. 11.

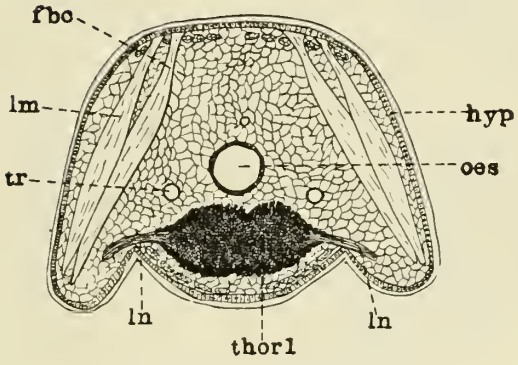


Fig. 12.

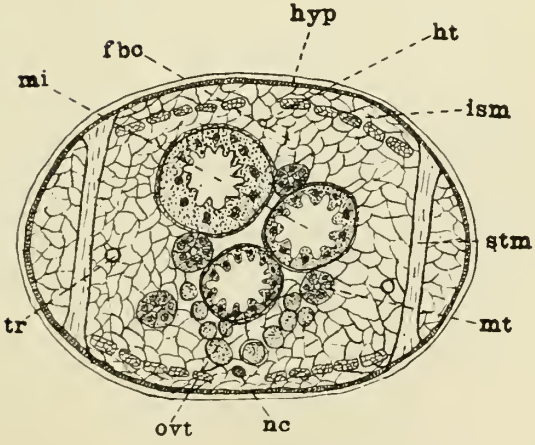


Fig. 13.

## PLATE VII.

Fig. 14. Tracheal system of a wingless adult female (somewhat diagrammatic).

Fig. 15. Diagram of the distribution of the tracheæ in a typical abdominal somite.

Fig. 16. Fore leg of an adult wingless female.

See page 113 for reference letters.

PLATE VII.

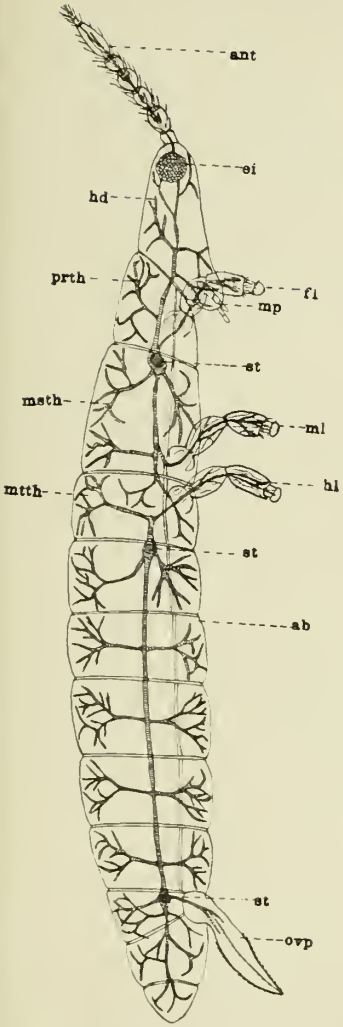


Fig. 14.

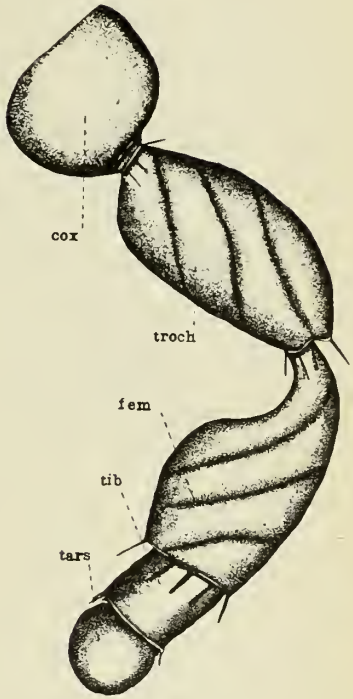


Fig. 16.

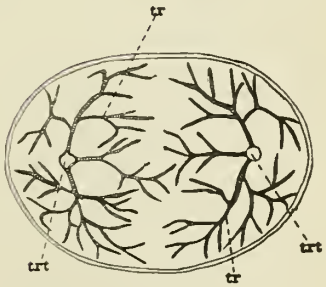


Fig. 15.

TREATMENT.

As the thrips feeds by sucking the juices of the plants, contact poisons, as kerosene emulsion, or whale oil soap, are the only ones which are of use in combating it.

Where only a small area is infested, one of the insecticides just mentioned or even a liberal application of water will prove successful in controlling the pest. When a large area is infested, the application of an insecticide is not feasible on account of the expense of materials and application. In such a case the burning of the dead stalks after the ground has frozen in the fall, so as to secure a close burn, without injuring the roots of the grass, may prove successful. With badly run out fields, which are the ones most likely to be badly infested, the best remedy is deep plowing in the fall or in the early spring before the grass has started. If this is followed by thorough cultivation, none of the insects will be able to make their way to the surface of the ground.